PATENT SPECIFICATION

(11) 1 421 928

1 421 928

(21) Application No. 14504/73 (22) Filed 26 March 1973 (19)

(44) Complete Specification published 21 Jan. 1976

(51) INT. CL.² G01P 5/00 G01D 21/02 G01P 5/06

(52) Index at acceptance

G1N 1A2P 1A3A 1C 1D13 1D7 3S2 3S6 4F2 7A1 7B2 7E1 7T1A

(72) Inventors PETER TILL and WALTER HEURITSCH

(54) APPARATUS FOR MEASURING THE SPEED AND DIRECTION OF A LIQUID FLOW

(71) We, VOGELBUSCH GESELLSCHAFT m.b.H., a Company with limited liability organized under Austrian law of 1110 Vienna, Mautner1Markhof-Gasse 40, Austria, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an apparatus for measuring the velocity and direction of fluid flow at a location.

Dynamic indicator tubes and measuring turbines are known means of measuring flow velocities; however, they measure only the strength of the flow and not its direction. To determine direction the flow-measuring facility needs to be positioned in various directions, and the observed flow velocity values can then form a basis for calculating flow direction, the highest observed value occurring when the measuring facility is oriented in the flow direction. This procedure is time-consuming and inaccurate, for a large number of measurements give only approximate measurement points. Another disadvantage is that, as a rule, all that can be measured in this way is the average flow in one flow section or portion, yet flow conditions vary of course in different parts of a flow cross-section, and so the time-consuming measurement operations would have to be completely repeated at various parts of the flow cross-section. For an accurate flow picture to be obtained, the number of measuring positions must be very large, and taking so many measurements at different positions would take so long that errors might occur due to the flow altering during the actual time that the measurements were being taken. Mechanisms enabling flowmeter orientation to be physically adjusted under external control are relatively elaborate and their presence alone falsifies flow conditions. The known facilities of this kind cannot therefore provide a satisfactorily accurate and practicable measurement of the strength and direction of flow.

In stationary anemometers it is known to measure wind speed by means either of cups mounted on the arms of a spider rotatable about avertical axis or of a propeller vane mounted for rotation about a horizontal axis in a head rotatable about a vertical axis. Wind direction in one known form of anemometer is determined by means of a rotating sleeve which is mounted on the stationary anemometer shaft, the wind rotor being disposed eccentrically on such sleeve, a worm being disposed on the wind-rotor shaft, the worm meshing with a worm-wheel fixedly mounted on the anemometer shaft. The rotating sleeve is adjusted until reaching a position in which the wind does not rotate the wind rotor. In the form of anemometer using a propeller vane, in order to determine wind direction, the rotating head can either be connected to the rotating sleeve or bear a radially projecting weather vane to bring it into the wind direction. To convert the observed values into electrical signals, a tachometer generator is coupled with the shaft of the cup spider or propeller vane for wind speed measurement and a potentiometer pickoff, having rubbing or rolling contacts, is used for sensing the angular position of the rotating head about its vertical axis and thus wind direction. The anemometer can determine only the horizontal components of the wind velocitly and direction. As regards the facilities which are used with known anemometers to convert the movements of the moving parts to usable signals the tachometer generator needs a finite minimum driving torque to rotate it even at a very low speed, and in the potentiometer pickoff there is of course friction, with consequent limitations of the accuracy of measurement of wind velocity and direction.

A water flow meter is known which can be lowered on a cable or chain from a ship to various depths. The flowmeter has a flow-immersed member which has directing surfaces and which always moves into the flow direction. In this known meter the flow velocity is measured by a turbine, the as-

sociated means for converting the observed value having a magnet which is disposed on the turbine shaft and which cooperates with a fixed contact operable by the field of the magnet. This system also comprises a pressure measuring cell for depth measurement, having an electrical resistance pickoff and an orientation measurement facility to determine the compass bearing of the flow immersed body, the latter facility comprising a compass magnet secured to the axis of a potentiometer pickoff. The flow-immersed member of this meter can take up the flow direction and determine the velocity vector; unfortunately, as in the case of the anemometer, the compass facility can detect only the horizontal direction component. This known facility cannot detect an elevation angle of the flow velocity vector; also, fairly large errors are likely in the orientation indication because of the friction of the potentiometer pickoff with which the compass magnet is coupled.

It is an object of the invention to provide apparatus for measuring the speed and direction of flow of a current of fluid which avoids the disadvantages and shortcomings of the known apparatus and in which the risk of error as a result of friction is much reduced compared with known apparatus.

According to the present invention there is provided apparatus for sensing the speed and direction of flow of a current of fluid comprising a flow body carried by an element mounted for pivoting freely on a fixed support about a first axis fixed with respect to said element, the flow body being pivotally mounted on said element for pivoting freely about a second axis fixed with respect to said element and transverse to said first axis, the flow body being shaped so as to adopt a predetermined orientation with respect to the direction of flow of a current of fluid flowing thereover, and being provided with means for sensing the velocity of fluid flow thereover, the apparatus including means for sensing the angular orientation of said flow body with respect to said element about said second axis, comprising a transducer in the form of an electrical transformer having at least one primary coil mounted in or on the flow body and at least one secondary coil mounted in or on the support, and means for sensing the angular orientation of said element with respect to said support about said first axis, comprising an electrical transformer having at least one primary coil mounted in or on said element, and at least one secondary coil mounted in or on said support, the apparatus further including means for feeding said primary coils with high frequency alternating current.

Since no physical contact, which would give rise to friction, is necessary between the flow body and said element, and between said element and said support in order merely to detect the angular positions of the flow body and said element about said second and first axes, the flow body can adjust itself very accurately to the direction of fluid flow thereover, accuracy of adjustment depending solely upon the quality of the mounting. In addition, the flow body can have or be connected to directing surfaces such as fins or vanes, but as will appear from what follows such fins or vanes have certain disadvantages. The provision of fins or vanes is vital in known facilities so as to overcome the friction of the means for sensing the angular disposition of the flow-body. However using directing surfaces of this kind compromises the accuracy of measurement. Thus, on the one hand, the forces tending to orient the flow body increase as the area of such fins or vanes is increased, so that the larger the vanes, the more likely is the flow body, in spite of the aforementioned friction to be oriented accurately in the mean direction of fluid flow over the body. However, on the other hand, the orientation measured is the mean flow orientation over the effective flow cross-section of the flow body, which cross-section is greater, the greater the extent of the vanes, so that the larger the vanes, the less accurately can the direction of flow at a particular point be assessed independently of the direction of flow at neighbouring points.

Conveniently, the secondary windings in or on the support are connected to an indicating station disposed outside the liquid flow. There is a wide range of choice for the indicating station since there are no special limitations on the length of electrical wiring extending to the station.

In the preferred embodiment, the high-frequency current which serves to energize at least one primary winding is modulated with information about the flow velocity. The advantage of this feature is that an existing circuit can be used to transmit velocity data, thus obviating the need for an extra line. The advantage of using high-frequency current is that even if the transduced windings are air-cored, (and in the preferred embodiment of the invention it is a consequence of the structure that they will at least have cores with relatively large non-magnetic gaps, which may be regarded as air-gaps, since such gaps must be left between the relatively movable parts, for example between said element and said support to permit free relative movement) transformation efficiency is relatively high.

Conveniently, the axes of the windings of the transformer sensing the angle of the flow body about said second axis lie in or extend parallel with the plane of the pivoting motion of the flow body about the second axis. As a rule, the primary winding is disposed in or

on the flow body and the secondary winding secured to the support is disposed coaxially of said first axis. This coaxial arrangement of the secondary winding with the axis around which the flow body can rotate leads to the advantage that the indicated response to pivoting of the flow body about said second axis is independent of its angle about said first axis so that the secondary winding can be disposed in the support, thereby avoiding current conducting connections between the moving parts and the indicating instrument, something which might restrict freedom of movement, thus further increasing the accuracy of adjustment of the flow body. Conveniently in this case, the primary winding which is in the flow-body extends parallel to the longitudinal axis thereof, with the advantage that in the range of pivoting of such member which occurs in practice, an unambiguous indication can be provided.

Conveniently, the or each primary-winding of the transducer for sensing the angle of said element about said first axis is disposed on said element which bears the pivot mounting for the flow-body and the or each secondary-winding is disposed on the support. This feature obviates the need to use current conducting connections, (which might restrict the mobility of said element about said first axis) for transmitting measurement results from the rotating part to the indicator. Since the support is fixed, wiring may be used for electrical connection of the or each secondary-winding for example to recording arrangements, without restricting movement of the flow body. The flow body is therefore completely free to move, and can therefore take up an accurate position in the flow direction in response to very small flow forces acting on it. Since the number of wires connected to the support does not impair measurement accuracy, a number of secondary-windings can readily be provided in the support. As an advantageous way of providing accurate detection of the rotational position of the rotating part in the preferred embodiment, two secondary windings of the transformer sensing the angle of said element about said first axis are disposed at an offset from one another around the first axis at an offset angle of other than 180°, more particularly at 90°, the two secondary windings cooperating with a single primary winding. The angles measured between the single primary windings and the two secondary windings correspond only to one particular rotational position and therefore give a clear indication of the actual position of the rotating part on which the flow-immersed member is mounted.

The measuring arrangement for the determination of the flow speed can advantageously have an impeller mounted coaxially on the flow body, with an electrical r.p.m. transducer. In this case the transducer can include, for example, an oscillator with an inductive feedback, whose resonant coil and feedback coil are disposed at a distance from one another, with a disk sector made of electrically conductive material and connected with the shaft of the impeller arranged to pass periodically between the resonant coil and the feedback coil as the impeller rotates so as to periodically interrupt the oscillation of the oscillator.

Alternatively, the measuring arrangement for the determination of the flow speed can be a hot film transducer disposed on the flow body, as a hot film anemometer, and if desired a converter can be provided to superpose the information supplied by the hot film anemometer on a high frequency electrical oscillation. In this manner one moving part of the flow body will be eliminated, whereby in some cases, especially when the temperature of the fluid, whose flow is being measured, has been determined accurately, the precision of measurement can be increased. If the temperature of the fluid has not been accurately determined, one could also adduce for the purpose of measurement the temperature differences of two hot film transducers disposed at various places of the flow body.

Both in the case of a measuring impeller as well as in the case of a hot film anemometer, the high frequency current serving to feed the primary coil or coils can be modulated with the information about the flow velocity. This is advantageous in that an existing circuit can be used for the transfer of information about the speed and thus an additional line can be avoided, i.e. the same information channel can be used for the indication of direction and speed.

In order to ensure the free movement of the flow body and to reduce to a minimum the mechanical resistance to the adjustment of the flow body in the direction of flow, it is advantageous to provide a contactless power supply for the parts of the transducers or converters, which are built into side element and/or into the flow body. For this purpose one can use a power transformer, whose primary winding is disposed on the support and whose secondary winding is disposed on said element directly opposite the primary winding, via which an alternating current lying preferably in the audio-frequency range is transmitted, the axes of the primary and secondary windings coinciding with said first axis. As a result of the fact that the axes of the primary and secondary windings coincide with the rotational axis, the coupling, and thus the power supply, is made independent of the angular position of said element about said first axis and the occurrence of electric forces which impede the movement of said element will be avoided.

In the preferred embodiment of the invention, the mechanical and also the electrical resistances to the adjustment of the flow body in the direction of flow are reduced to a minimum and a precise adjustment of the flow body in the direction of flow will become possible so that it will adopt a position in which its effective flow cross section will be smallest.

An embodiment of the invention is described below with reference to the accompanying drawings in which:

Figure 1 shows a system of coordinates with the velocity vector of a fluid current drawn in;

Figure 2 shows an embodiment of the device according to the invention in side view, partially broken away;

Figure 3 shows the transformer arrangement of the transducer for the elevation angle in side view; and

Figure 4 shows the transformer arrangement of the transducer for the azimuth angle in plan view.

In Figure 1 the velocity vector of a current of fluid has been inserted in a system of three mutually perpendicular coordinates x, y, z. For the definition of the direction of the velocity vector, it will be most convenient to give the angles φ and ν of a system of spherical coordinates, called in the succeeding paragraphs azimuth angle and elevation angle, in connection with the device. Furthermore, the magnitude $/v/$ of the velocity vector, i.e. the corresponding flow speed is to be determined. The determination of all these quantities is possible with the device shown in Figure 2.

In Figure 2, a flow body 1 is mounted for rotation about vertical axis of rotation 3 and is pivotable about a pivot, having a pivotal axis 2 which is horizontal in the position shown in Figure 2. The mounting permitting rotation of body 1 about axis 3 includes an element 5 mounted for rotation about axis 3 on a fixed support 4, the element 5 carrying on opposite sides thereof vertically extending supports 6 to the upper ends of which the body 1 is pivotally connected for pivoting about the axis 2. Inside rotatable element 5, a central pipe 7 fixed at its lower end to support 4 projects upwards from support 4, and at its upper end bears a fixed part 8. The element 5 is, of course, freely rotatable about pipe 7. In order to increase the moments exerted on the movable parts by the flowing fluid (in the embodiment shown intended to be a liquid) a horizontal fin 9 is provided on flow body 1 and a vertical vane 10 on rotatable element 5.

In order to transmit, record and possibly process the measured values of the relevant quantities, φ, ν, and $/v/$ it will be most convenient if these values are translated in the flow meter itself to electrical signals. At the same time, a contactless transmission of these signals from the movable parts of the flow meter to its locally fixed support is possible. To provide an electrical signal indicative of the elevation angle ν of the flow body, i.e. its angle with respect to the horizontal about pivotal axis 2 a transducer is employed which is in the form of an electrical transformer, with a primary coil 11 fed with high frequency current, which is disposed with its axis parallel to the longitudinal axis of flow body 1, (the last mentioned axis lying in the direction of flow of fluid over the body 1), and is mounted within said body, the transformer having a secondary coil 12 which is disposed at the uppermost end of fixed part 8 of the support within the latter and with its axis coincident with rotational axis 3. As a result of the fact that the axis of secondary coil 12 coincides with axis 3 of rotation, the electromotive energy induced in it by the field of primary coil 11 depends only on the elevation angle of flow body 1, but is independent of its azimuth angle. Since secondary coil 12 is mounted in a fixed part of the flow meter, the arrangement of conductors from the secondary coil to the pertinent recording arrangement is not subject to any limitations and neither movable conductors nor slip rings are required for the electric transmission of signals. In the case of the position of flow body 1 as drawn, in which the axis of coil 11 is perpendicular to axis 3, no voltage is induced in secondary coil 12. Upon pivoting flow body 1 out of the position shown in Figure 2, about axis 2 voltage induced in the secondary coil 12 increases up to a maximum value, while the phase sense of the induced voltage with respect to that applied across coil 11 depends on whether the body 1 has been tilted in one direction or the other about axis 2. The elevation angle can thus be determined uniquely by measuring the amplitude of the voltage taken from secondary coil 12 and by comparison of the phase sense of this voltage with the phase sense of the voltage applied to coil 11. The basic arrangement of the transducer for determining the elevation angle has been shown in Figure 3. By use of a high frequency current to feed primary coil 11, the transformer 11, 12 can be made as an air-cored transformer, whereby the coils have a relatively low number of turns and can be manufactured in a geometric shape which can be easily reproduced. The operating frequency, therefore, should not be too low if it is to be possible to make do with coils with a relatively low number of turns, while, on the other hand, upper limit of the frequency which can be used is determined by the electric characteristics of the surrounding fluid. For practical purposes, the lowest attenuation between primary coil and

secondary coil will result in the frequency range between 50 kHz and 100 kHz.

In the apparatus shown in Figure 2, an electric transducer in the form of a transformer is also provided for the determination of the azimuth angle, which transducer has a primary coil 13, fed with high frequency current and disposed in rotatable element 5, and two secondary coils 14 and 15 disposed in the fixed upper part 8 of the support. The axes of the coils 13, 14 and 15 lie parallel with the axis 3 and outside the axis 3. A top view of this arrangement of coils is shown in Figure 4. If only a single secondary coil were to be assigned to the primary coil, then an unequivocal electric recording of the azimuth angle could be achieved only within a range of 180°, i.e. only if the element 5 were limited to rotation through 180° would the actual position of element 5 be uniquely determinable. An unequivocal electric recording of the angle over the entire range of 360° can be achieved by providing two secondary coils 14 and 15, which around rotational axis 3 are displaced with reference to one another by an angle deviating from 180°, in the case shown by way of an example by an angle $\varphi 3=90°$ (Figure 4). To every value of the azimuth angle in the range of 0 to 360° only a single ratio combination of the voltages take from the secondary coils 14 and 15 corresponds. This also can be explained in the following way: If angle $\varphi 1$ or $\varphi 2$ is determined from the voltages taken from coils 14 and 15, then two solutions will be obtained for every angle. But it is easy to find the correct one from each of these two solutions, because $\varphi 1+\varphi 2+\varphi 3$ must be 360°, i.e. at any instant the voltage across coil 14 will provide two possible angles of the element 5. Similarly the voltage across coil 15 will provide two possible angles of the element 5, but only one of these will correspond to one of the possible angles indicated by the reading across coil 14, and this must be the correct angle. Since secondary coils 14 and 15 also are disposed on a fixed part of the flow meter, the guidance of the measuring conductors from the coil connections to the pertinent recording arrangement offers no difficulties.

An impeller 16 mounted coaxially on flow body 1 is provided for the determination of the flow speed. The r.p.m. of the impeller and thus the information regarding the flow speed can be converted in different manners and ways to an electric signal. In the present instance there is disposed in the flow body an oscillator 21 with an inductive feedback, whose resonant coil 17 and feedback coil 18 are disposed at a distance from one another. An electrically conductive disk sector 20, secured to the impeller shaft 19, passes once during every revolution of impeller shaft 19, through the gap between the two coils 17, 18 and, as a result, interrupts the oscillation of the oscillator. The frequency of the pulse modulation of the oscillation of the oscillator thus is a measure for flow speed /v/. Oscillator circuit 21, shown in Figure 2 as a small box, contains, besides the actual oscillator, also an impedance transformer with limiter characteristics, as a result of which the influence of transients caused by the triggering of the oscillator with the aid of revolving disk sector 20, is largely suppressed. The oscillator operates in the frequency range between 50 and 100 kHz and at the same time it delivers the high frequency current feeding primary coils 11 and 13 of the transducers assigned to the measuring arrangements for the determination of the elevation angle and the azimuth angle. The pulse modulation of the oscillation voltage which already exists is not disturbing in the case of its further use. Rather, this will result in the advantage that, for the transmission of the information regarding the flow speed, no separate conductor is required because this information also is available in the pulse modulation of the voltages taken from coils 12, 14 and 15. Since the phase of the voltages induced in coils 14, 15 with respect to that applied to coil 11 is invariable, these voltages provide a phase reference with which the phase of the voltage induced in coil 12 can be compared to determine whether the elevation angle is positive or negative.

In order not to impede the freedom of rotatable element 5 for rotation with flow body 1 about axis 3, a contactless energy supply to the electrical circuitry housed in the flow body and in the rotatable element is provided. A power transformer whose primary winding 22 is disposed on the fixed support 4 serves for this purpose. Primary winding 22 is supplied by power by a generator 23. The operating frequency of generator 23 lies in the audio frequency range, for example at about 3kHz. Secondary winding 24 of the power transformer is disposed on rotating element 5 directly opposite the primary winding. In order to achieve a good coupling, the primary and secondary windings are each housed in a half of a pot core made of ferrite material. Although only one side of the pot core and windings 22, 24 are shown in Figure 2, it will be appreciated that the pot core and the windings 22, 24 exhibit rotational symmetry about axis 3, so that coupling is unaffected by rotation of element 5 about axis 3. Since the A.C. voltage of audio frequency available at the secondary winding 24 is not suitable for a direct supply to the oscillator 21 and associated circuitry it is rectified, smoothed and possibly stabilized before feeding to the oscillator circuit 21 and the associated circuitry. The rectify-

ing, smoothing and stabilizing circuitry may be housed in element 5 or in body 1.

A flexible cable 25 is provided for connection between rotatable element 5 and flow body 1, which in this case has no disturbing effect, because the range of pivotal movement of body 1 about axis 2 is limited to less than 180°. The cable 25 provides the power supply to the body 1 and also the connection between oscillator 21 and coil 13. The cable 25 does not, of course, pass through the stationary support but may be mounted along one of the arms 6.

The measured signals are guided via conductors 26 (passing through the centre of the pot core) to recording arrangements 27 to 31 which include a recording arrangement 27 for the elevation angle ν and recording arrangements 28 and 29 for the angles $\varphi 1$ and $\varphi 2$ respectively from which, in an arrangement 30, the azimuth angle φ can be deduced. Since the information regarding flow velocity is impressed on the high frequency oscillations as a modulation, any desired signal voltage fed in via conductors 26, for example the signal voltage assigned to angle $\varphi 2$, can be fed to recording arrangement 31 for recording the flow velocity.

Since the apparatus does not rely upon work done by the fluid flowing past it to produce the electrical energy for the signals corresponding to the measured values, it absorbs only a very small part of the kinetic energy of the current of fluid and thus disturbs the quantities measured only very slightly. On the other hand, the transmitted signals can be amplified as desired so that recording measuring instruments can be used even if the output signals of the transducers are very small, or the signals can also be utilized for control devices.

Furthermore, almost any distances between the place of measurement and the place of indication or recording are possible, data processing instruments may be used for the evaluation, and there is great latitude in the selection of the indicating or recording process.

While in the foregoing description the axis 3 has been referred to for convenience as being vertical and the axis 2 as being horizontal, the corresponding angles about these axes being referred to as azimuth and elevation angles, it will be appreciated that in practice the apparatus may be mounted in any orientation e.g. with axis 3 horizontal and axis 2 moving in a vertical plane.

WHAT WE CLAIM IS:—

1. Apparatus for sensing the speed and direction of flow of a current of fluid comprising a flow body carried by an element mounted for pivoting freely on a fixed support about a first axis fixed with respect to said element, the flow body being pivotally mounted on said element for pivoting freely about a second axis fixed with respect to said element and transverse to said first axis, the flow body being shaped so as to adopt a predetermined orientation with respect to the direction of flow of a current of fluid flowing thereover, and being provided with means for sensing the velocity of fluid flow thereover, the apparatus including means for sensing the angular orientation of said flow body with respect to said element about said second axis, comprising a transducer in the form of an electrical transformer having at least one primary coil mounted in or on the flow body and at least one secondary coil mounted in or on the support, and means for sensing the angular orientation of said element with respect to said support about said first axis, comprising an electrical transformer having at least one primary coil mounted in or on said element, and at least one secondary coil mounted in or on said support, the apparatus further including means for feeding said primary coils with high frequency alternating current.

2. Apparatus according to claim 1 wherein the secondary coils mounted in or on the support are connected with indicating means disposed outside of the current of fluid.

3. Apparatus according to claim 1 or 2 including means for modulating the high frequency alternating current fed to at least one of the primary coils with flow velocity information.

4. Apparatus according to any one of claims 1 to 3, in which the axes of the coils of the transducer for sensing the orientation of the flow body about said second axis lie in or extend parallel with the plane of the pivoting motion of the flow body about the second axis.

5. Apparatus according to any one of claims 1 to 4, wherein the axis of the secondary coil of the transducer for sensing the angular orientation of the flow body about said second axis is coincident with said first axis.

6. Apparatus according to claim 5, wherein the axis of the primary coil of the transducer for sensing the angular orientation of the flow body about said second axis lies parallel with the longitudinal axis of the flow body, which is the axis of the latter which lies in the direction of fluid flow over the body.

7. Apparatus according to any one of claims 1 to 6, wherein the transducer for sensing the angular orientation of said element about said first axis has two seecondary coils disposed in or on said support and spaced apart angularly with respect to said first axis by an angle differing from 180°, and has a single primary coil mounted in or on said element, whereby the angular position of said element with respect to said

support can be determined from the absolute magnitude and the relative magnitudes of the voltages induced in said secondary coils.

8. Apparatus according to claim 7 wherein said two secondary coils are spaced 90° apart about said first axis.

9. Apparatus according to claim 7 or 8, wherein the axes of all the coils of the transducer for sensing the orientation of said element about said first axis lie parallel to said first axis and outside of it.

10. Apparatus according to any one of claims 1 to 9, wherein means for supplying electrical power to said primary coils includes a power supply transformer whose primary winding is disposed in or on said support and whose secondary winding is disposed in or on said element directly opposite the primary winding, whereby electrical power can be supplied to said element without electrical contacts between the latter and said support by passing an alternating current through the primary winding of said power transformer, the primary and secondary windings of said power transformer exhibiting rotational symmetry about said first axis so that the coupling therebetween does not vary with the angular position of said element about said first axis.

11. Apparatus according to any one of claims 1 to 10, wherein the flow body is provided with fins or vanes to cause it to adopt a predetermined orientation with respect to the direction of fluid flow.

12. Apparatus according to any one of claims 1 to 11, wherein the means for the determination of the flow velocity includes an impeller mounted coaxially on the flow body and an electrical rpm transducer comprising an inductive feedback oscillator whose resonant coil and feedback coil are disposed at a distance from one another, a disk sector made of electrically conductive material being connected with the shaft of the impeller, which sector passes through the gap between the resonant coil and the feedback coil as the impeller rotates.

13. Apparatus according to any one of claims 1 to 11, wherein the means for the determination of the flow velocity includes a hot film transducer disposed on the flow body as a hot film anemometer.

14. Apparatus according to claim 13, wherein a converter is provided for impressing the information supplied by the hot film anemometer on a high frequency electrical oscillation.

15. Apparatus for sensing the speed and direction of flow of a current of fluid, substantially as hereinbefore described with reference to and as shown in Figures 2 to 4 of the accompanying drawings.

FORRESTER, KETLEY & CO.,
Chartered Patent Agents,
Forrester House,
52 Bounds Green Road,
London N11 2EY,
and at
Rutland House,
148 Edmund Street,
Birmingham B3 2LD.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

FIG. 1

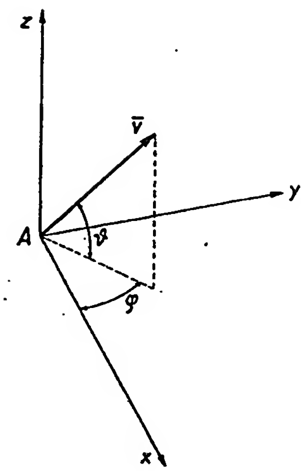


FIG. 3

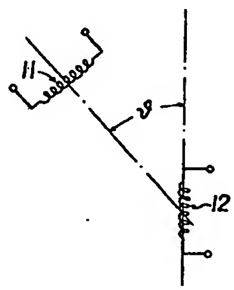


FIG. 4

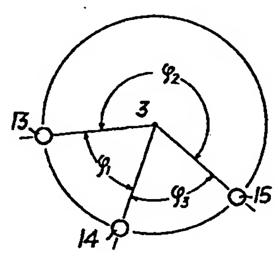
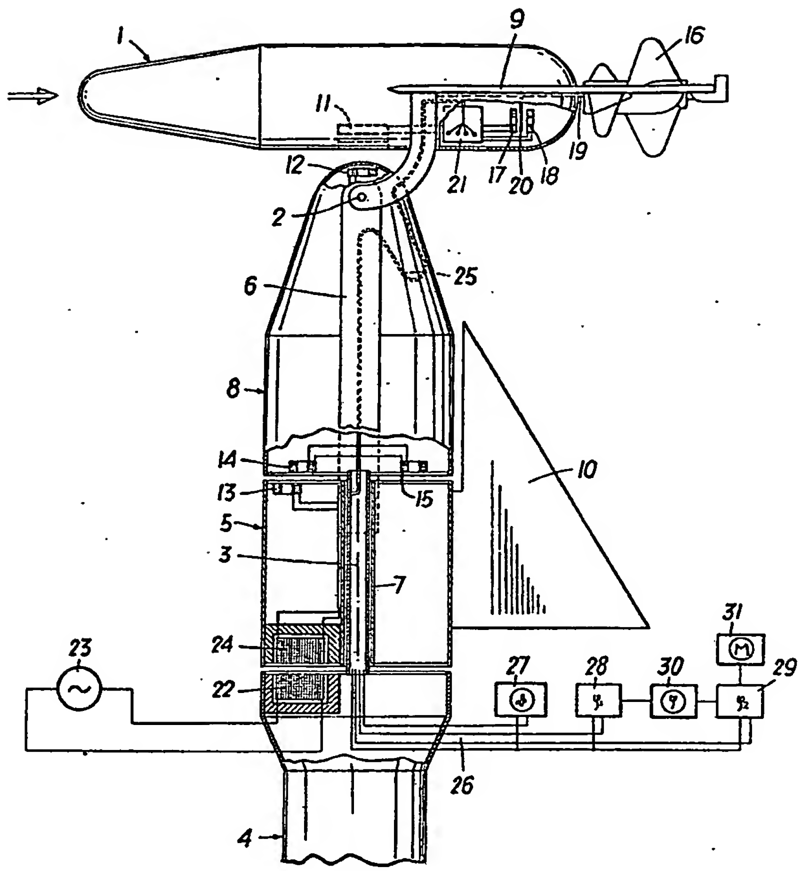


FIG. 2


1
9
16
11
12
21
17
20
18
19
2
25
6
8
14
13
15
10
5
3
7
31
23
24
27
28
30
29
22
26
4